

Cost-effectiveness of community-based HIV self-testing in Blantyre, Malawi

Hendramoorthy Maheswaran^{1,2,3}; Aileen Clarke²; Peter MacPherson^{1,4}; Felistas Kumwenda³; David G Lalloo^{3,4}; Elizabeth L. Corbett^{3,5}; Stavros Petrou²;

1. Department of Public Health and Policy, University of Liverpool, UK
2. Division of Health Sciences, University of Warwick Medical School, Coventry, UK
3. Malawi-Liverpool-Wellcome Trust Clinical Research Programme, Blantyre, Malawi
4. Department of Clinical Sciences, Liverpool School of Tropical Medicine, UK
5. London School of Hygiene and Tropical Medicine, London, UK

Corresponding author:

Hendramoorthy Maheswaran

Department of Public Health and Policy

University of Liverpool

Liverpool L69 3GB (UK)

Email: hendym1@liverpool.ac.uk

summary: A cost-effectiveness analysis of community-based HIV self-testing (HIVST) suggests that implementation is potentially cost-effective in Malawi. The scale-up of HIVST is suited to high HIV prevalence countries that target early diagnosis and initiation of anti-retroviral treatment.

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Abstract

Background: HIV self-testing (HIVST) is effective, with scale-up underway in sub-Saharan Africa. We assessed cost-effectiveness of adding HIVST to existing facility-based HIV testing and counselling (HTC) services. Both 2010 (initiate at CD4<350 cells/ μ l) and 2015 (initiate all) WHO guidelines for antiretroviral treatment (ART) were considered.

Methods: A microsimulation model was developed that evaluated cost-effectiveness, from both health provider and societal perspectives, of an HIVST service implemented in a cluster-randomised trial (CRT) (ISRCTN02004005) in Malawi. The economic model drew upon health outcomes data observed in the CRT, and primary health economic studies undertaken in the trial population. Costs and health outcomes were evaluated over a 20-year time horizon, using a discount rate of 3%. Probabilistic sensitivity analysis was conducted to account for parameter uncertainty.

Results: From the health provider perspective and 20-year time horizon, facility HTC using 2010 WHO ART guidelines was the least costly (US\$294.71 per person, 95%CrI:270.79-318.45) and least effective (11.64 QALYs per person, 95%CrI:11.43-11.86) strategy. Compared to this strategy, the incremental cost-effectiveness ratio (ICER) for facility HTC using 2015 WHO ART guidelines was US\$226.85 (95%CrI:198.79-284.35) per quality-adjusted life year (QALY) gained. The strategy of facility HTC plus HIVST, using 2010 WHO ART guidelines, was extendedly dominated. The ICER for facility HTC plus HIVST, using 2015 WHO ART guidelines, was US\$253.90 (95%CrI:201.71-342.02) per QALY gained compared with facility HTC and using 2015 WHO ART guidelines.

Conclusions: HIVST may be cost-effective in a Malawian population with high HIV prevalence. HIVST is suited to an early HIV diagnosis and treatment strategy.

Key words: HIV; HIV self-testing; ART; cost-effectiveness; cost-utility

Introduction

More than half of all people living with HIV (PLHIV), new HIV infections and HIV-related deaths are in East and Southern Africa [1]. Despite intensive efforts to meet 90-90-90 UNAIDS testing, treatment and retention goals, nearly half of PLHIV remain unaware of their HIV status [2]. HIV testing and counselling (HTC) in health facilities is essential but remains underutilised [3]. Community-based HIV testing strategies have greater reach, but delivering these services remains costly, difficult to sustain, and can fail to offer satisfactory levels of privacy [4].

HIV self-testing (HIVST) resolves many of these issues by enabling individuals to perform and interpret their own HIV test result in private [2], and can be delivered to communities safely and at low cost by trained volunteers [5, 6]. HIVST has achieved high population HTC uptake, especially amongst men, and good rates of linkage into HIV treatment [5]. However, no formal economic evaluation has been undertaken to inform policy makers in the region whether scaling-up self-testing offers efficient use of scarce resources.

Recently, a pragmatic cluster-randomised trial (CRT) was undertaken to investigate the impact of offering population-wide HIVST through community volunteers in Blantyre, Malawi (ISRCTN02004005) [5]. In this study, we undertook a cost-effectiveness analysis of this community-based HIVST intervention. We sought to use clinical effectiveness and economic data collected from participants of this trial [5, 7, 8], as well as data from secondary sources, and extrapolate the findings to the population-level and over longer time horizons than observed in the trial. We additionally explored the effects of changes in WHO and Malawian antiretroviral treatment (ART) initiation guidelines, which occurred after completion of the trial [9].

Methods

Analytic overview

We developed a microsimulation model to explore the impact of implementing HIVST in communities with high HIV prevalence and available facility-based HTC. The model simulates health provider and societal costs, and health consequences of acquiring HIV infection, HIV disease progression and initiation of ART. Simulating these costs and health consequences at the individual-level has the advantage that parameters (e.g. likelihood of accessing HIV testing) can reflect individual-level characteristics (e.g. age, sex). The model drew heavily upon evidence from the CRT [5].

HIV testing and treatment strategies

During the CRT (February 2012 to August 2014), Malawi used the 2010 WHO ART guidelines, with ART initiated if the patient had CD4 counts <350 cells/mm³, was WHO stage 3 or 4, or was pregnant or breastfeeding [10]. Since August 2016, Malawi has used the 2015 WHO ART guidelines with ART offered to all HIV-positive individuals [9]. We therefore evaluated four strategies. The base-case was defined as (1) availability of facility HTC, using 2010 ART guidelines. We compared this strategy to: (2) availability of facility HTC plus HIVST, using 2010 ART guidelines; (3) availability of facility HTC, using 2015 ART guidelines; and (4) availability of facility HTC plus HIVST, using 2015 ART guidelines. We did not consider the potential impact of other HIV prevention interventions.

Decision-analytic model

Decision-analytic modeling used TreeAge Pro 2017 (TreeAge Software, Williamstown, Massachusetts). Figure 1 provides an overview of the model structure, which contained four health states; (1) HIV-negative; (2) HIV-positive and not on ART; (3) HIV-associated co-morbidities; and (4) HIV-positive and on ART. Every month, individuals transitioned through these health states. The model records, and in some cases updates, certain characteristics including: sex; age; HIV status; CD4 count; WHO clinical stage; ART status; and months of ART received. These characteristics were used to estimate uptake of HIV testing; HIV incidence and prevalence; eligibility for ART initiation; risk of mortality; risk of HIV associated co-morbidities; and retention on ART.

Characteristics of individuals

Baseline population characteristics were estimated from the trial post-intervention survey in control clusters, showing 58% of participants were female; mean age 30 years; HIV prevalence ranged from 2.3% in 16-19 year old males to 28.6% in 40-49 year old females; 2.1% HIV-positive with a CD4 count ≤ 50 cells/ μ l and 36.6% HIV-positive with a CD4 count > 500 cells/ μ l (Table 1).

HIV testing and linkage into HIV care

Trial data were used to derive probabilities for accessing each testing modality by sex and age [5]. Individuals who tested HIV-negative did not re-test for one year. In the trial, the HIVST service was provided independently of existing facility-based HTC; we therefore assumed mutually exclusive probabilities for accessing HIV testing modalities. Those who tested HIV-positive through HIVST incurred an additional cost for facility-based confirmatory HIV testing. A cohort study conducted before introduction of HIVST provided estimates of linkage into HIV treatment after facility HTC [11]. Linkage into HIV treatment after HIVST was based on trial findings [5]. For strategies including 2010 WHO ART guidelines, data from the literature were used to model the likelihood of those not eligible for ART returning for repeat assessment for ART initiation [12-17].

Transition probabilities

Death occurred from HIV-related [18, 19] and unrelated causes, with Malawian specific age- and sex mortality rates used to model HIV-unrelated mortality [20]. HIV-negative individuals were at risk of acquiring HIV infection. As the model did not allow for interaction between individuals modeled [21], we assumed HIV incidence varied by age and sex but was otherwise constant and used estimates from a South African study with comparable ART coverage to Malawi [22].

For HIV-positive individuals, a CD4 count was assigned on entry into the model or when infected with HIV. HIV-positive individuals' CD4 counts decreased if not receiving ART, and increased if receiving ART [23], with rates of change estimated from previous studies [16, 19, 24-27]. Modelled CD4 counts determined individual eligibility to start ART, and likelihood of HIV-associated co-morbidity or death. The model simulated progression to WHO clinical stages 3 or 4 [18] to account for ART eligibility under 2010 WHO guidelines.

The model was parameterised to account for time-varying rates of ART discontinuation [28]. If treatment was discontinued, individuals returned to the "HIV-positive not on ART" health state. The model did not account for ART failure, or HIV viral load monitoring as this was not offered at the time of the trial. ART failure may require switching to more expensive second line ART regimens; however, this remains uncommon in the region [29].

For HIV-associated co-morbidities, we only considered the costs and impact on health-related quality of life (HRQoL) arising from hospitalisation [30]. For HIV-positive individuals not on ART, we multiplied the risk of experiencing these HIV associated co-morbidities [18, 27] by the risk of hospitalisation [18]. For HIV-positive individuals on ART, we additionally multiplied these risks by the relative reduction in hospitalisation attributable to ART [31]. We assumed that HIV-positive individuals on ART who were hospitalised continued to take ART. We assumed individuals who experienced these co-morbidities would undergo HIV testing with a similar likelihood of linking into HIV treatment as after facility HTC. Additional information about the modelling approach (Appendix A), model parameter synthesis processes (Appendix B) and model external validation procedures (Appendix C) are provided in the appendices.

Costs

The direct health provider and societal costs of facility HTC, HIVST, assessment for ART eligibility, and ART were all derived from primary costing studies that recruited participants from the CRT [7, 8]. The costs associated with different HIV associated co-morbidities were derived from primary costing of adult medical admissions to the main public hospital in Blantyre [30]. Costs were adjusted to reflect the one-month cycle length used in the model. Societal costs incorporated estimates of direct health provider costs, direct non-medical costs and indirect costs. Table 2 shows the cost parameters in 2014 US dollars.

Health-related quality of life

The primary health outcome was quality-adjusted life years (QALYs), estimated by multiplying health utility scores assigned to the different health states in the model by the time spent in each health state, and summing across health states [32]. Utility scores varied by HIV status. For HIV-positive individuals, utility scores decreased as CD4 count decreased, and following HIV-associated co-morbidity [33, 34]. Utility scores for all health states were derived from primary economic studies in Blantyre that recruited participants from the CRT [7, 8], or from adult medical admissions [30]. In these studies the Chichewa version of the EuroQoL EQ-5D-3L [35] was used to assess HRQoL of participants. The EQ-5D utility scores for the health states were derived using the Zimbabwean [36] EQ-5D tariff set (Table 3).

Cost-effectiveness analysis

The model was used to project the costs and QALYs for each testing/ART strategy. A time horizon of 20 years rather than the standard lifetime horizon [32] was used, given likely changes in HIV incidence, and testing and treatment strategies over time. Scenario analyses included alternative time horizons of 10 and 40 years.

Probabilistic sensitivity analysis (PSA) was used to address parameter uncertainty. The beta distribution was fitted to transition probabilities and health state utilities, and the gamma distribution for costs [37]. For each strategy, we ran 5,000 model runs, randomly selecting a value for each parameter from its distribution. For each model run, we estimated total costs and QALYs for a sample of 5000 individuals.

We report mean discounted costs and QALYs per person across these simulations for each testing/ART strategy. We estimated the mean incremental cost and incremental QALYs by comparing the least costly and least effective strategy to the next least costly and least effective strategy. The incremental cost-effectiveness ratio (ICER) for respective comparators was calculated by dividing incremental costs by incremental QALYs gained. We excluded strategies that were dominated, i.e. less effective and more costly, or extendedly dominated, where the ICER for the strategy is higher than a more effective strategy. All

results are presented with 95% credible intervals (CrI). This interval represents the 2.5th and 97.5th percentiles from the distribution of results from all simulations. Separate analyses were undertaken from health provider and societal perspectives [32]. Costs are represented in 2014 US and International dollars, and a discount rate of 3% was applied to both costs and health effects.

We compared estimated ICERs against increasing cost-effectiveness thresholds: US\$0/QALY; US\$250/QALY; US\$500/QALY; US\$750/QALY. For each testing/ART strategy, we present the probability of cost-effectiveness at these thresholds. This probability represents the proportion of all simulations where the estimated ICER was below the specified cost-effectiveness threshold [32]. As we compared multiple strategies, and because decision makers may have different cost-effectiveness thresholds, we also present cost-effectiveness acceptability frontiers (CEAF) [38] to show which strategy is optimal at increasing cost-effectiveness thresholds. We undertook a series of deterministic sensitivity analyses, using the point estimate for all parameters except the one being explored, to evaluate the impact on the ICER. We estimated the ICERs across the plausible ranges for the parameter of interest and present findings in a tornado plot.

Results

Health provider costs

Over a 20-year time horizon and health provider perspective, availability of facility HTC and using 2010 WHO ART guidelines was the least costly strategy (US\$294.71 per person, 95%CrI:270-318.45) (Table 4). The next least costly strategy was facility HTC and using 2015 WHO ART guidelines (US\$336.13 per person, 95%CrI:313.35-358.64). The two strategies of facility HTC plus HIVST, using either the 2010 or 2015 WHO ART guidelines, had higher mean discounted costs of US\$380.27 (95%CrI:355.08-404.54) and US\$438.79 (95%CrI:416.75-461.12) per person, respectively.

Societal costs

Over a 20-year time horizon and societal perspective, facility HTC and using 2010 WHO ART guidelines was the least costly strategy (US\$334.70 per person, 95%CrI:306.45-363.54). The next least costly strategy was facility HTC and using 2015 WHO ART guidelines (US\$377.67 per person, 95%CrI:351.29-405.16). The two strategies of facility HTC plus HIVST, using either the 2010 or 2015 WHO ART guidelines, had higher mean discounted societal costs of US\$422.82 (95%CrI:392.19-452.10) and US\$484.16 (95%CrI:456.30-512.96) per person, respectively.

Health outcomes

Over a 20-year time horizon, facility HTC and using 2010 WHO ART guidelines was the least effective strategy (11.64 QALYs per person, 95%CrI:11.43-11.86). The next least effective strategy was facility HTC and using 2015 WHO ART guidelines (11.82 QALYs per person, 95%CrI:11.62-12.03). Facility HTC plus HIVST, using either the 2010 or 2015 WHO ART guidelines, were more effective, generating 11.99 (95%CrI:11.80-12.18) and 12.23 (95%CrI:12.06-12.40) QALYs per person, respectively.

Cost-effectiveness analyses

From the health provider perspective and 20-year time horizon, the ICER for facility HTC and using 2015 WHO ART guidelines was US\$226.85 (95%CrI:198.79-284.35) per QALY gained compared with facility HTC and using 2010 WHO ART guidelines (Table 4). The strategy of facility HTC plus HIVST and using 2010 WHO ART guidelines was extendedly dominated. The

ICER for facility HTC plus HIVST and using 2015 WHO ART guidelines was US\$253.90 (95%CrI:201.71-342.02) per QALY gained compared with facility HTC and using 2010 WHO ART guidelines.

From the societal perspective and 20-year time horizon, the ICER for facility HTC plus HIVST and using 2015 WHO ART guidelines was US\$234.69 (95%CrI:198.76-297.52) per QALY gained compared with facility HTC and using 2010 WHO ART guidelines. The strategy of facility HTC plus HIVST and using 2010 WHO ART guidelines was extendedly dominated. The ICER for facility HTC plus HIVST and using 2015 WHO ART guidelines was US\$262.68 (95%CrI:203.75-363.20) per QALY gained compared with facility HTC plus HIVST and using 2010 WHO ART guidelines. Appendix D shows the findings when the costs were estimated in 2014 International Dollars.

Table 4 shows the probability that each strategy is cost-effective at cost-effectiveness thresholds of: US\$0/QALY; US\$250/QALY; US\$500/QALY; US\$750/QALY. Figure 2 shows the CEAF for the optimal strategies across increasing cost-effectiveness threshold values. Up to a threshold value of approximately US\$200, the strategy of facility HTC and using 2010 WHO ART guidelines remained optimal in cost-effectiveness terms. At a cost-effectiveness threshold of US\$250/QALY, the strategy of facility HTC and using 2015 WHO ART guidelines was optimal. At threshold values higher than approximately US\$270, facility HTC plus HIVST and using 2015 WHO ART guidelines was the optimal strategy.

Scenario analyses

Over both the 10- and 40-year time horizons, the strategy of facility HTC plus HIVST and using 2015 WHO ART guidelines remained optimal at cost-effectiveness thresholds above US\$500 per QALY (Table 5).

Deterministic sensitivity analyses

Figure 3 shows a tornado plot from the deterministic sensitivity analysis comparing the strategy of facility HTC plus HIVST and using 2015 WHO ART guidelines to the strategy of facility HTC and using 2015 WHO ART guidelines. The uptake of facility-based HIV testing and HIVST, cost of HIVST episode, and the HIV prevalence and incidence in the population had the greatest impact on the ICER. Appendix E provides more detail on the findings from the deterministic sensitivity analysis.

Discussion

In this study, we undertook an economic evaluation of a community-based HIV self-testing service in Blantyre, Malawi, and estimated cost-effectiveness, taking into account recent changes in the guidelines for when individuals should start ART. Overall, we found that providing community-based HIVST and using the 2015 WHO ART guidelines was the optimal strategy at cost-effective thresholds above US\$270/QALY. The gross domestic product in Malawi is approximately US\$250 per capita. The finding that delivering HIV testing closer to people's homes is cost-effective is not new [39]; however, to our knowledge, this is the first evaluation of HIVST strategies using robust data from a large cluster randomised trial, combined with primary economic studies.

Adopting the 2015 WHO ART guidelines or implementing HIVST will result in higher healthcare costs. In Malawi, adopting the 2015 WHO ART guidelines would cost healthcare providers an additional US\$41 per capita over the next 20 years, and would equate to a 14% increase in HIV testing and treatment expenditure. Adopting both strategies would cost US\$144 per capita over the next 20 years and 49% increase in HIV testing and treatment expenditure, but implementation would have a synergistic effect, resulting in the greatest health gains. Uptake of HIV testing remains sub-optimal in the region [2], with HIV-positive individuals still only accessing HIV treatment services with advanced HIV disease [40]. Implementing HIVST may be necessary to achieve the hoped-for health benefits from universal access to ART, but needs to be balanced against local budgetary constraints and whether investing in other HIV and non-HIV interventions offers better value for money.

We previously estimated the cost per individual tested through HIVST to be comparable to facility-based HTC [7]. The cost of HIVST kits is currently eight-times that of the rapid finger prick test kits used in health facilities. We found the cost of an HIVST episode and ART provision to be important drivers of cost-effectiveness. If the cost of an HIVST episode were lower, achievable if the cost of an HIVST kit fell from current estimates of \$4 per kit, and the cost of ART provision lower, through lower ART drug costs, implementing HIVST and adopting the 2015 WHO ART guidelines would become more affordable for policymakers in the region.

There are several limitations. Firstly, our analysis does not consider the impact of HIV transmission. In comparison to the base-case, the three other strategies examined resulted in a net gain in QALYs, as well as increased numbers on ART. As HIV infections averted depends on ART coverage amongst HIV-positive individuals, considering HIV transmission is likely to have led to lower ICER estimates; therefore our findings represent conservative estimates. Secondly, we did not consider the impact of individuals failing ART. At the time of the trial, and health economic studies, HIV viral load monitoring was not routinely available in Malawi and only 3% of HIV-positive individuals in the region had switched to second-line ART regimens [29]. However, as all strategies examined result in more HIV-positive individuals taking ART, the need for HIV viral load monitoring and costlier second-line ART regimens will increase. This is likely to lead to less favorable ICERs than those estimated. Finally, we only considered the impact of HIV associated illnesses that required hospitalisations, and did not consider other illnesses which are managed in the community or at primary health clinics. Again, as the costlier strategies result in earlier initiation of ART, had we considered these additional health sequelae, the ICER estimates would likely have been lower.

Achieving high coverage of ART is essential to eliminating the HIV epidemic in sub-Saharan Africa, but will require substantial increases in population rates of HIV testing. HIVST is

popular and can have a major impact on population coverage of HIV testing with relatively little input from trained health professionals [5, 6]. We found implementing HIVST to be potentially cost-effective. Notably, our model suggests that the transition from restricted ART availability to the 2015 WHO ART guidelines of immediate offer of ART irrespective of CD4 count, combines favourably with HIVST. Without effective community HIV testing programmes, the health benefits of universal access to ART are limited by inability to detect early HIV efficiently under facility-only testing strategies. HIVST is therefore suited to an early HIV diagnosis and treatment strategy.

NOTES

Contributors: HM conceived and designed the study, conducted cost and statistical analysis and drafted the manuscript. SP, AC and ELC supported design of study and data collection tools. All authors interpreted the data, prepared report and approved final version.

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Figure 1: Overview of microsimulation model developed

ART: Anti-retroviral treatment

Figure 2: Cost-effectiveness acceptability frontier showing optimal strategy at increasing cost-effectiveness threshold values for gain in quality-adjusted life year

ART: Anti-retroviral treatment

HTC: HIV testing and counselling

HIVST: HIV self-testing

QALY: Quality-adjusted life year

2010 WHO ART initiation guidelines: CD4 count <350 cells/mm³ or WHO stage 3 or 4

2015 WHO ART initiation guidelines: start ART irrespective of CD4 count or WHO stage

Figure 3: Tornado diagram showing findings from deterministic sensitivity analysis

UV: Univariate/one-way sensitivity analysis

MV: Multivariate sensitivity analysis

ART: Anti-retroviral treatment

HTC: HIV testing and counselling

HIVST: HIV self-testing

ICER: Incremental cost-effectiveness ratio

QALY: Quality-adjusted life year

KS: Kaposi's sarcoma

Table 1: Overview of base-case model parameters

Parameter	Data	Sources
Individual characteristics		
Age and sex demographics	58% female; mean age 30 years	Unpublished trial data (Post intervention survey)
HIV prevalence	2.3-28.6% (age and sex dependent)	
CD4 counts in HIV-positive	36.6% CD4 count >500 cells/μl	
	23.4% CD4 count 351-500 cells/μL	
	22.8% CD4 count 201-350 cells/μl	
	15.2% CD4 count 51-200 cells/μl	
	2.1% CD4 count =<50 cells/μl	
HIV testing and linkage into HIV care		
Annual uptake of facility HTC	14.7-53.0% (age and sex dependent)	Unpublished trial data
Annual uptake of HIVST	40.8-99.9% (age and sex dependent)	[5]
Linkage after facility HTC	50.7% (95%CI: 44.9-56.6)	[11]
Linkage after HIVST	41.7% (95%CI: 38.8-44.4)	[5]
HIV incidence and mortality		
HIV incidence	0.66-6.49 per 100 person years (age and sex dependent)	[22]
Non-HIV mortality	Malawi life tables (age and sex dependent)	[20]
HIV mortality, not on ART	0.6-69.5 per 100 person years (CD4 count dependent)	[18]
HIV mortality, on ART	1.4-14.0 per 100 person years (CD4 count dependent)	[19]
Mean change in CD4 count		
Not on ART	Decreases 4.0-5.7 cells/month (CD4 count dependent)	[16, 25-27]
On ART	Increases 1.3 cells/week (95%CI: 1.1-1.5)	[19]
HIV treatment outcomes		
Pre-ART returning for ART assessment in 6 months	57.1% (95%CI: 56.0, 58.0)	[12-17]
Retention on ART	0-6 months: 86.1% (95%CI: 84.6, 87.4) 7-12 months: 80.2% (95%CI: 78.0, 82.4) 13-24 months: 76.1% (95%CI: 72.4, 79.7) >24 months: 72.3% (95%CI: 67.4, 76.9)	[28]
HIV-associated illnesses	CD4 count dependent	[18, 27]

ART: Anti-retroviral treatment

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Table 2: Health provider and societal costs for model (2014 US)

Cost Parameter		2014 US Dollars						Distribution
		Health provider costs			Societal costs			
		Base case	Low	High	Base case	Low	High	
Facility-based HTC episode		8.90	7.53	10.57	10.68	9.91	11.45	Gamma
HIV self-testing episode		8.78	7.78	10.46	8.85	7.97	9.72	
Assessment for ART eligibility for all clients		22.27	21.32	23.21	25.46	24.14	26.79	
Annual cost of ART for facility HTC clients		168.65	164.69	172.62	181.91	175.38	188.45	
Annual cost of ART for facility HIVST clients		164.66	156.41	172.90	179.38	164.29	194.46	
Cost of hospital admission for severe HIV associated illness	Acute diarrhoea	300.97	134.37	467.56	481.56	190.30	772.82	
	Chronic diarrhoea	233.06	93.84	372.28	372.28	114.42	407.39	
	Oesophageal candidiasis	153.08	69.92	236.24	236.24	65.30	292.59	
	Invasive bacterial diseases	223.45	199.68	247.21	247.21	229.39	291.01	
	Pulmonary tuberculosis	437.68	339.02	536.33	536.33	441.79	716.81	
	Extra-pulmonary tuberculosis	494.68	394.83	594.53	594.53	526.86	1014.00	
	Malaria	199.63	106.55	292.72	292.72	69.06	647.84	
	Malignancy (KS/Lymphoma)	242.92	195.53	290.31	290.31	244.64	389.41	
	Pneumocystis Jivorecii pneumonia	325.56	268.15	382.97	382.97	294.62	495.67	
	Cryptococcal meningitis	846.24	651.05	1041.44	1041.44	760.87	1194.62	

HTC: HIV testing and counselling

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Table 3: EQ-5D utility scores for health states (Zimbabwean and UK tariff)

Utility Parameters		EQ-5D Utility scores			Distribution
		Base case	Low	High	
HIV negative		1.000	1.000	1.000	Beta
HIV-positive not on ART	CD4 >200 cells/ μ l	0.878	0.802	0.954	
	CD4 51 to 200 cells/ μ l	0.840	0.762	0.917	
	CD4 count \leq 50 cells/ μ l	0.654	0.558	0.749	
Increase over first year on ART for facility-HTC clients		0.129	0.107	0.150	
Increase over first year on ART for HIVST clients		0.139	0.087	0.192	
Hospital admission for severe HIV associated illness	Acute diarrhea	0.367	0.143	0.590	
	Chronic diarrhoea	0.476	0.316	0.636	
	Oesophageal candidiasis	0.349	0.170	0.529	
	Invasive bacterial diseases	0.499	0.457	0.541	
	Pulmonary tuberculosis	0.429	0.349	0.509	
	Extra-pulmonary tuberculosis	0.389	0.296	0.481	
	Malaria	0.567	0.412	0.721	
	Malignancy (KS/Lymphoma)	0.420	0.320	0.521	
	Pneumocystis Jivorecii pneumonia	0.559	0.398	0.719	
	Cryptococcal Meningitis	0.478	0.386	0.569	

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Table 4: Cost-effectiveness findings from primary analysis and 20 year time horizon (2014 US Dollars)

Perspective	HIV testing strategy	ART initiation guideline	Discounted mean costs and QALYs per person				ICER	**Probability cost-effective at cost-effectiveness threshold (US\$ per QALY)				
			2014 US Dollars		QALYs			2014 US\$ per QALY	0	250	500	750
			Mean cost	Incremental cost	Mean Effectiveness	Incremental Effectiveness						
			(*95% CrI)	(*95% CrI)	(*95% CrI)	(*95% CrI)						
Health Provider	Facility HTC	2010 WHO ART	294.71	-	11.64	-	-	1.000	0.128	0	0	
			(270.79, 318.45)		(11.43, 11.86)	-						
	Facility HTC	2015 WHO ART	336.13	41.42	11.82	0.18	226.85	0	0.362	0.001	0	
			(313.35, 358.64)	(29.86, 55.64)	(11.62, 12.03)	(0.12, 0.25)	(198.79, 284.35)					
	Facility HTC & HIVST	2010 WHO ART	380.27	-	11.99	-	ED***	0	0.207	0	0	
			(355.08, 404.54)		(11.80, 12.18)	-						
	Facility HTC & HIVST	2015 WHO ART	438.79	102.66	12.23	0.40	253.90	0	0.303	0.999	1.000	
			(416.75, 461.12)	(85.45, 120.04)	(12.06, 12.40)	(0.28, 0.53)	(201.71, 342.02)					
Societal	Facility HTC	2010 WHO ART	334.70	-	11.64	-	-	1.000	0.178	0	0	
			(306.45, 363.54)		(11.43, 11.86)	-						
	Facility HTC	2015 WHO ART	377.67	42.98	11.82	0.18	234.69	0	0.368	0.003	0	
			(351.29, 405.16)	(30.33, 58.84)	(11.62, 12.03)	(0.12, 0.25)	(198.76, 297.52)					
	Facility HTC & HIVST	2010 WHO ART	422.82	-	11.99	-	ED***	0	0.238	0.001	0	
			(392.19, 452.10)		(11.80, 12.18)	-						
	Facility HTC & HIVST	2015 WHO ART	484.16	106.49	12.23	0.40	262.68	0	0.215	0.996	1.000	

	(456.30, 512.96)	(84.90, 128.67)	(12.06, 12.40)	(0.28, 0.53)	(203.75, 363.20)
HTC: HIV testing and counselling	HIVST: HIV self-testing	ART: Anti-retroviral treatment	CrI; Credible interval		
QALYS: Quality-adjusted life years ICER: Incremental cost-effectiveness ratio ED: Extendedly dominated					
2010 WHO ART initiation guidelines: CD4 count <350 cells/mm ³ or WHO stage 3 or 4					
2015 WHO ART initiation guidelines: start ART irrespective of CD4 count or WHO stage					
*95% CrI: represents the 2.5 th and 97.5 th percentile from the distribution of results from all the simulations					
**Probability represents the proportion of all simulations where the estimated ICER was below the specified cost-effectiveness threshold. Total may not add up to 1.0 as for some simulations, no single scenario was found most cost-effective at given cost-effectiveness threshold					
***Extended dominance: The ICER for this strategy higher than the next more effective strategy.					

Table 5: Cost-effectiveness findings from the health provider perspective over different time horizons (2014 US Dollars)

Time horizon	HIV testing strategy	ART initiation guideline	Discounted mean costs and QALYs per person				ICER	**Probability cost-effective at cost-effectiveness threshold (US\$ per QALY)				
			2014 US Dollars		QALYs			2014 US\$ per QALY	0	250	500	750
			Mean cost	Incremental cost	Mean Effectiveness	Incremental Effectiveness						
			(*95% CrI)	(*95% CrI)	(*95% CrI)	(*95% CrI)						
10 years	Facility HTC	2010 WHO ART	157.77	-	7.45	-	-	1.000	0.998	0.031	0	
			(142.53, 171.95)		(7.35, 7.55)	-						
	Facility HTC	2015 WHO ART	184.86	27.09	7.52	0.07	389.43	0	0	0.211	0.019	
			(172.07, 197.65)	(19.99, 36.41)	(7.42, 7.61)	(0.04, 0.10)	(311.05, 520.51)					
	Facility HTC & HIVST	2010 WHO ART	206.82	-	7.56	-	ED***	0	0.002	0.054	0.002	
			(190.24, 221.96)		(7.47, 7.65)	-						
	Facility HTC & HIVST	2015 WHO ART	247.64	62.78	7.67	0.15	430.47	0	0	0.704	0.979	
			(234.64, 260.74)	(53.20, 72.58)	(7.58, 7.74)	(0.09, 0.20)	(323.11, 645.72)					
20 years	Facility HTC	2010 WHO ART	294.71	-	11.64	-	-	1.000	0.128	0	0	
			(270.79, 318.45)		(11.43, 11.86)	-						
	Facility HTC	2015 WHO ART	336.13	41.42	11.82	0.18	226.85	0	0.362	0.001	0	
			(313.35, 358.64)	(29.86, 55.64)	(11.62, 12.03)	(0.12, 0.25)	(198.79, 284.35)					
	Facility HTC & HIVST	2010 WHO ART	380.27	-	11.99	-	ED***	0	0.207	0	0	
			(355.08, 404.54)		(11.80, 12.18)	-						
	Facility HTC & HIVST	2015 WHO ART	438.79	58.52	12.23	0.24	247.92	0	0.303	0.999	1.000	

			(416.75, 461.12)	(44.32, 76.69)	(12.06, 12.40)	(0.16, 0.32)	(207.60, 312.97)				
40 years	Facility HTC	2010 WHO ART	408.07 (372.67, 445.05)	-	15.13 (14.72, 15.55)	-	-	1.000	0	0	0
	Facility HTC	2015 WHO ART	461.25 (424.82, 498.46)	-	15.46 (15.05, 15.88)	-	ED***	0	0.007	0	0
	Facility HTC & HIVST	2010 WHO ART	530.83 (495.99, 565.74)	122.77 (99.18, 146.04)	15.92 (15.64, 16.28)	0.79 (0.55, 1.03)	155.58 (127.21, 204.37)	0	0.033	0	0
	Facility HTC & HIVST	2015 WHO ART	602.34 (569.01, 635.77)	71.51 (51.89, 95.18)	16.32 (15.99, 16.66)	0.41 (0.24, 0.59)	175.77 (146.77, 236.34)	0	0.960	1.000	1.000

HTC: HIV testing and counselling

HIVST: HIV self-testing

ART: Anti-retroviral treatment

CrI: Credible interval

QALYS: Quality-adjusted life year

ICER: Incremental cost-effectiveness ratio

ED: Extendedly dominated

2010 WHO ART initiation guidelines: CD4 count <350 cells/mm³ or WHO stage 3 or 4

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*95% CrI: represents the 2.5th and 97.5th percentile from the distribution of results from all the simulations

**Probability represents the proportion of all simulations where the estimated ICER was below the specified cost-effectiveness threshold. *Total may not add up to 1.0 as for some simulations, no single scenario was found most cost-effective at given cost-effectiveness threshold

***Extended dominance: The ICER for this strategy higher than the next more effective strategy.

Figure 1.

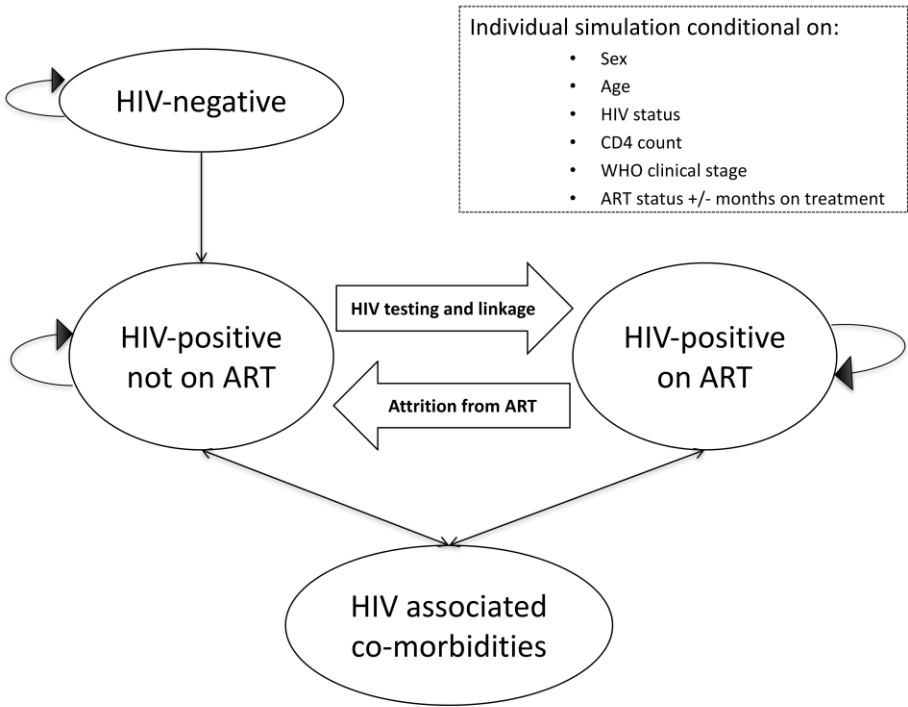


Figure 2.

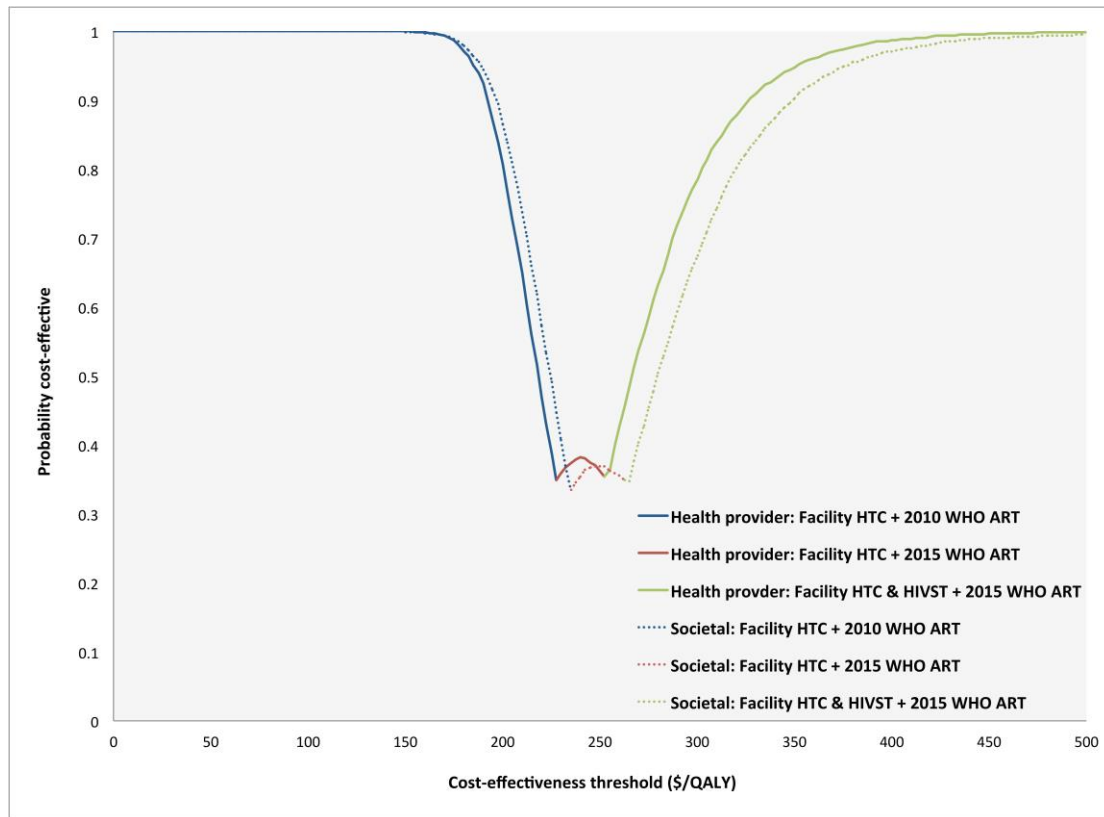


Figure 3.

